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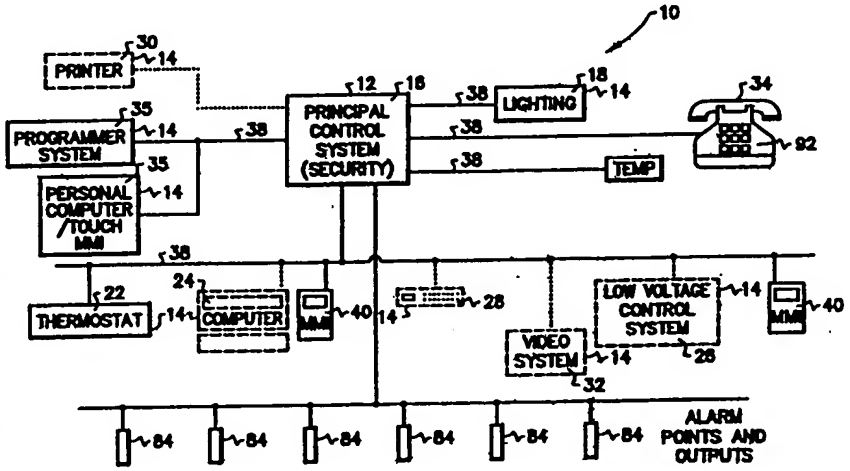
(54) Title: A SYSTEM AND METHOD FOR AUTOMATICALLY CONTROLLING A SPACE

(57) Abstract

A system and method for controlling a space, wherein the space may be a building or buildings, including both residential and nonresidential buildings. A principal control system, which may include a security system, has the ability to control a plurality of control systems, including individual control devices. The principal control system has a main processor means, a memory means and interconnections to a plurality of control systems, and is capable, through the use of these elements, of controlling and integrating the control of these systems. Through a single selection made by an operator, control can be exercised automatically over the plurality of control systems, including the principal control system. Control is accomplished by predetermining and preprogramming a plurality of desired control modes, and storing these control modes in the memory means of the principal control system, such as a security system. Each control mode is designed to incorporate information defining a desired set of conditions which the space is to be controlled to. For example a "leave" mode may define the desired status of a plurality of control systems, such as a security system (e.g. armed), an HVAC system (e.g. setback temperature to a defined level), a lighting system (e.g. turn predefined lights on) as well as others. The modes are used in conjunction with the system to automate the control of a space.



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A SYSTEM AND METHOD FOR AUTOMATICALLY CONTROLLING A SPACE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention includes a system for automatically controlling a space by integrating the control and function of a plurality of control systems and devices utilized within the space, by using a principal control system, such as a security system. These control systems and devices can include an environmental control system, a telecommunications system, a lighting control system, and other electrical control systems including those which control individual electrical or electronic devices such as appliances, audio devices and video devices. This invention also includes a method of automating the control of a space by integrating the control and function of the various control systems utilized, through the execution of preprogrammed control modes which correlate to events having to do with the principal control system, such as security related events, and are executed through the operation of elements of the security system. These preprogrammed control modes contain information for the control of the principal control system, such as the security system, and the control systems and devices, based on the occurrence of certain control events related to the principal control system, such as events related to security, where a security system is the principal control system. More particularly, this invention pertains to building control systems which integrate various control systems and devices of the types described above, such that any one or all of them can be commanded to perform various of the tasks or functions for which they were designed, by the selection of a single, preprogrammed control mode. Therefore, building control requiring a plurality of control systems and devices can be accomplished automatically by a single selection made by an operator. Specifically, this invention relates to a security-event based home automation system of the type described above that includes a plurality of preprogrammed control modes, which

have embedded in them certain control commands for controlling control systems and devices of the types listed, and which are incorporated so as to permit the execution of the control steps for all of the systems and devices whose function, or functions, is desired in that particular control mode. The invention can be accessed by a user from within the space to be controlled, or remotely through the use of a telecommunications interface. The control systems may be separately operable, although not automated, when used without being connected to the principal control system, or when the principal control system has failed. Additionally, the control modes can be preprogrammed into the system by connecting a programming device to the system, or remotely via a telecommunications interface.

2. Description of Related Art

Systems currently exist for automatically controlling a space by integration of various systems or subsystems related to the space which is to be controlled. These include automation systems which cover a broad range of control applications from the control of large commercial buildings, such as multi-story office buildings, to the control of residential, small commercial and other buildings.

In the case of large commercial buildings, integration is typically accomplished using an automation system which incorporates a series of programmable controllers, such as programmable digital controllers, each of which can be flexibly configured to control a plurality of control systems within the building, such as heating, ventilating and air conditioning (HVAC) systems; lighting control systems; access control systems and security systems. These programmable controllers can be programmed or configured, either separately or in groups, using a programming device, and often are controlled on a continuous basis through the use of a central computer system, which may have master programming and central control responsibilities of all the programmable controllers. These programmable controllers must be configured for the specific system or device to be controlled, before they can be usefully incorporated into the automation system. Automation systems for large systems are generally not adaptable to application in smaller

buildings, such as residential or small commercial buildings, because the cost of incorporating the functionality into the programmable controllers in order to make them flexible enough for a variety of configurations, makes these systems too expensive to be commercially practicable in smaller buildings. Also, the control logic and algorithms applicable for large commercial buildings do not typically apply directly to the HVAC, lighting, security and other systems found in residential, small commercial and other buildings, because the equipment used in these systems and use in buildings is quite different than that used in large buildings. Also, the control of large commercial buildings tends to be largely time-based, such that the control algorithms are activated based on a particular time of the day. In instances where event-based activation is utilized, the activation can be based on user input from a central computer station (e.g. configuring an athletic arena in preparation for an upcoming athletic event). Event-based activation has also been used in response to a system-sensed condition, such as a fire alarm, where a programmable controller which senses the alarm condition will report the alarm condition to the central computer station, and the central computer station will execute instructions to the remainder of the system based on the nature of the sensed condition.

In the context of residential, small commercial and other buildings, a multitude of so called automated control systems and methods have been both suggested in the literature and actually implemented. These "automated" control systems have consisted of several general types, including those in which control of various systems is integrated through the use of a central processor or computer, such as a commercially available personal computer, and those which perform the integration through a dedicated central control panel. These systems have not been successful in achieving widespread consumer acceptance for a number of reasons, including limited integration of control systems, cost, and the lack of a simple to operate approach for the non-gadget oriented user.

In the past, automation systems for controlling a space have often not integrated enough of the major systems in residential, small commercial or other

buildings, such as HVAC, security, lighting and electrical device control, or coordinated them in such a limited way as to not provide enough of a user benefit to justify the cost, added effort, or both, required to operate these systems. One reason that broader integration has not generally been accomplished is that the various systems found in existing homes or small commercial buildings, or available for use in new homes, are not constructed to be integrated. No common communications protocol or common hardware interface method exists among the systems of interest. Therefore, integration of these systems is very difficult, including being both time consuming and expensive and, in some cases, the various systems are so dissimilar as to be nearly impossible to interconnect them such that their control can be integrated. Various communication protocols and interface methods have been suggested, but none have found widespread commercial acceptance by all, or even the majority, of manufacturers which make control products for these applications. In addition, a number of these communications protocols and interface methods have suggested an interface solution at a device or component level, without providing an overall solution of the type required to integrate systems which incorporate these devices or components into a building-wide integrated system.

In instances where integration of control devices have been implemented, the resulting systems have been very expensive, and not affordable for the vast majority of consumers, because they do not provide a common communications protocol or hardware interface. In addition, because no common communications protocol or hardware interface exists, the highest degree of integration that has been accomplished has been to have a central control unit execute individual commands for the various systems which have been integrated, which commands are executed over transmission media specific to the device which is receiving the command, and which is not connected to other devices. In such systems, each integration of an additional device typically results in a separate development effort to resolve the communication and interface issues associated with that specific device, because of the lack of a standard communication protocol and/or hardware interface.

The fact that truly integrated solutions have been very difficult and costly to implement, has led to another general category of solutions which consist essentially of a central control panel. In these systems, a central control panel is provided which permits a user to execute, from the panel, at least some of the functions of various control systems located within the building. Usually, not all of the functionality of the various control systems can be implemented from the central control panel, but only some subset of designated functions. In such systems, the user must actually perform the integration by selecting which of the functions of the various systems he desires to invoke. Each time one of the systems requires a change, an operator must separately consider whether changes to other systems should be implemented as well, and this process must be repeated every time similar is required, which is a very limited form of integration, and not really automation.

One of the significant problems in providing a building automation system which integrates various control systems, is to define a user interface and method of using such a control system which first provides integrated and automated control solutions to an operator in a way which accommodates the operator's requirements with respect to controlling the building. Secondly, the control solution must fit, as nearly as possible, the operator's normal use of the space such that the operator does not view the system as a separate system to be controlled, but rather a system which is implemented as part of the normal activity or simplification of the normal activity to which an operator is accustomed when using the space. This problem has associated with it concepts of "user friendliness", wherein it is necessary to provide a user interface which can be readily understood and utilized without the need for separate training or the need to remember a large amount of operation related instructions. But the problem is also much deeper than that, in that the user interface should also fit in to normal activity, or events, encountered when utilizing the space. For example, consider the implementation of such a system in a home setting. In such a setting, to utilize a user interface which is essentially a central control station, such as a personal computer, activity is required which may be outside the scope of normal home

activity, such as sleeping, waking, eating, entertaining and other typical home activities, for some homeowners. For instance, in order to invoke control of the various systems related to a homeowner's going to bed for the evening, he or she must first access the central control station and execute the necessary commands to invoke the control functions desired for that activity. In such an example, although building automation control is provided through the user interface, it may not fit well with a homeowner's normal activity patterns when utilizing his or her home. Therefore, while providing a building integration and automation solution, the solution may not be desirable due to a number of drawbacks principally related to the user interface and control methodology. Such drawbacks can effect an operator's willingness to use an automation system. Therefore, the selection of a user interface, and methodology for using the user interface, is a critical aspect of a building automation system. It is important that the user interface and control methodology match well certain usage patterns desired for the space, and that they require that an operator adopt no, or very minimal, changes in usage patterns to utilize the system.

SUMMARY OF THE INVENTION

The present invention is a system which provides for automated control of a space. More specifically, this invention relates to a system for providing automated control of various systems and devices typically found in a space, such as a building. This invention may be particular applicability to small commercial buildings, homes and similar buildings. Specifically, the invention provides a principal control system which is capable of automatically integrating the control and/or function of various systems and devices typically located within a building.

In a preferred embodiment the present invention comprises a security system as the principal control system. The security system has the necessary hardware and software to integrate the control of other control systems, including the security system, such as those controlling HVAC, lighting and other electrical systems and devices, such as entertainment related devices, telecommunications, and other systems

typically located within a building. The security system has a plurality of direct and bus-based interconnections, for serial digital communication with the various control systems and devices which are to be integrated. The bus-based serial communications comprises a communication protocol, or code, which permits communication to a plurality of devices through a single serial interface.

The invention has a processor means for integrating and coordinating control instructions to the various systems and devices which are connected to the system.

The invention also includes a plurality of preprogrammed instructions located in a memory means which is connected to the processor means, which instructions define a plurality of control modes which are used to integrate the control of the security system and the various control systems and devices which are attached to the system. These modes define the control instructions necessary to accommodate a plurality of different control conditions for the space which is to be controlled. These modes are invoked through the normal operation of the security system. Thus, in the preferred embodiment, the system could be characterized as being principally security-event based, in that security-related events that occur as a result of an operator's normal utilization of the space trigger the control of both the security system and the other control systems and devices located within the space. These preprogrammed instructions can be stored in the memory means by connecting a programming device to the system directly and transferring program instructions into the memory means for storage, or by remote access via a telecommunications interface, such as a modem.

The security system can be operated via a plurality of input devices, including a security panel, or panels located in one or more locations within the home, telephones located within the home via a voice module, and remotely from a telephone or similar telecommunications device also via the voice module.

A principal object of this invention is to provide a system which integrates and automates the control systems typically found within a building. A second object of the invention is to provide an automation system for controlling a space, which can be

utilized by a user as part of the ordinary utilization of the space, such as by utilizing a security system without in any way comprising the integrity of the security function.

A third object of the invention is to provide an automation system for controlling a space, which interconnects a plurality of devices through the use of a single communication protocol and hardware interface.

A fourth object of the invention is to provide an automation system for controlling a space, which not only integrates the control of the various control systems and devices which are attached to it, but which is also capable of receiving information from said systems and devices which can be further utilized by the automation system and/or provided to an operator, in order to permit the operator to utilize such information in making decisions about control of the space.

A principal advantage of the preferred embodiment of the invention, is that integration and automation of the control systems and devices located within the space through inputs to the security system, allow automated control to be accomplished without requiring that a user perform an additional control-related task, or tasks, in that for spaces which incorporate security systems, the operation of the security system is part of the normal pattern of activity of an operator in the usage of the space.

Other objects, features and advantages of the invention may be apparent to one of ordinary skill in the art, upon examination of the drawings and detailed description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of an embodiment of a system for automating the control of a space, featuring a security system as a principal control system, a plurality of control systems, and the interconnections between the security system and the plurality of control systems.

Figure 2 is a block diagram of the security system of Figure 1, illustrating the general location and interrelation of certain principal elements.

Figure 3a is a more detailed functional block diagram of the security system of Figure 2.

Figure 3b is a continuation of the functional block diagram of Figure 3a.

Figure 4 is a front view of the home security panel.

Figure 5 is a block diagram of a home security panel showing its interconnection to the control panel.

Figure 6 is a floor plan of a sample house using the inventive system.

Figure 7 is a matrix of modes, statuses and points within the house of Figure 6.

Figure 8 is a flow chart of the method of operation of the inventive system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Figure 1, an automation system 10 for automatically controlling a space is illustrated. In a preferred embodiment of the invention as described herein, automation system 10 would be particularly suitable for automatically controlling a building, such as a small commercial building, a home, or a similar building. Automation system 10 comprises a principal control system 12 connected to a plurality of control systems 14. In a preferred embodiment of the invention, principal control system 12 is security system 16 electrically connected to plurality of control systems 14, including lighting system 18 and thermostat 22. Other control systems 14 could be electrically connected to security system 16, including personal computer system 24, low voltage control system 26, entertainment system 28, printer system 30, and video system 32, as well as any number of other systems which might be located in or near the building, and including systems which could be remote from the building and interconnected via telecommunications device 34 or otherwise. In a preferred embodiment of the invention, a control system 14 which could be remote from security system 16, could include programming system 35. The following describes security system 16, plurality of control devices 14 and their interconnection.

Referring now to Figure 2, security system 16 includes several principal elements including control panel 36, interconnections 38, one or more home security panels (HSP) 40, and plurality of control points 84.

Referring now to Figure 3a and 3b, control panel 36 comprises processor means 44 and memory means 46 which are interconnected by address line 48 and data line 49. In a preferred embodiment, processor means 44 comprises a plurality of separate processors including main processor 50, data bus processor 52 and control point processor 54, however, processor means could also be implemented in a single device. In a preferred embodiment, the three processors are all 8-bit microprocessors or microcontrollers, and are all interconnected via address line 48 and data line 49.

Referring now to Figures 1, 2 and 3a, main processor 50 is the principal data processing device for automation system 10. It is capable of providing a plurality of output signals, for transmission to the plurality of control systems 14, in response to the receipt of a plurality of input signals. Input signals can be provided from systems and devices comprising control systems 14, HSP 40, other systems, and devices capable of providing input signals 60. Main processor 50 is capable of transmitting to, and receiving signals from, other processors, such as data bus processor 52 and control point processor 54, and other devices.

Referring now to Figures 2, 3a and 5, data bus processor 52 controls the communication of information between main processor 50 of security system 16 and control systems 14, such as thermostat system 22, as well as other devices which are connected to data bus 62, such as HSP 40. The exchange of information between data bus processor 52, control systems 14, and devices such as HSP 40,including HSP processor 41 is accomplished through the use of an encoded (4B-8B) data stream utilizing a code, and a method of receiving and transmitting the code described in the co-pending application, "A DC Balanced 4B/8B Binary Block Code for Digital Communications", filed herewith, by D. Myers, which is hereby incorporated by reference.

Control point processor 54 is capable of receiving a plurality of inputs from control points 84, and transmitting the input information to main processor 50 via address line 48 and data line 49.

As described herein, in addition to processor means 44, control panel 36 also comprises memory means 46. In a preferred embodiment, memory means 46 comprises a combination including Electrically Programmable Read Only Memory (EPROM) 64, Random Access Memory (RAM) 66 and Electrically Erasable Programmable Read Only Memory (EEPROM) 68. Particularly, memory means 46 is capable of storing a preprogrammed set of instructions 70 relating to a set of control conditions or modes desired within the building, and providing these instructions to main processor 50 via address line 48 and data line 49 in response to a request made by an operator.

Referring now to Figures 2 and 3a, having described the elements of control panel 36, automation system 10 also comprises plurality of interconnections 38 to provide for the connection of principal control system 12 and plurality of control systems 14. In a preferred embodiment, this arrangement comprises security system 16 interconnected with control systems 14, such as lighting system 18, voice access system 20 and thermostat 22, via lighting interconnection 74, voice access interconnection 76 bus interconnection 78, respectively. In a preferred embodiment, these interconnections are all accomplished via digital data interfaces.

Referring now to Figure 3a, lighting interconnection 74 is accomplished via a direct RS232 serial interface to main processor 50. Voice access interconnection 76 to main processor 50 is accomplished via address line 48 and data line 49, and thermostat interconnection is accomplished via a data bus using an RS485 serial interface to data bus processor 52, which is in turn connected via a serial interface to main processor 50.

Referring now to Figure 4, security system 16 also comprises HSP 40, which is now further described. HSP 40 is a man-machine interface (MMI). In a preferred embodiment, the MMI comprises a touch key-pad 80 and a display 82, such as a

liquid crystal display. Display 82 is capable of identifying for an operator the available choices with respect to control of the automation system 10, as well as displaying certain indications of system status, such as time, date, temperature, and current mode 82. In one embodiment, touch key-pad 80 has, on the key-pad, a combination of numeric keys, arrow symbol keys and word keys to facilitate operator selections, as discussed further herein, and as shown in Figure 4.

Referring now to Figure 2, security system 16 also comprises control points 84. Control points 84 include two types of security points, RF points 86 and hardwire points 88. These control points are of a type well known in the art, such as those utilized in any one of the System 6000 series security systems manufactured and sold by Honeywell Inc., such as model 6400, and are interconnected to control panel 36 through control point processor 54, using interconnection methods and materials known to those of ordinary skill in the art. The exact number of RF points 86 and hardwire points 88 is a function of the capabilities of control point processor 54. Various adapters are known to those of ordinary skill in the art which can be utilized to expand the number of control points 84 which can be attached to control point processor 54. Control point processor 54 is capable of monitoring and exercising control over individual control points 84, and providing information about any individual control point 84 to main processor 50. Therefore, this information is available to security system 16, and particularly so that modes can define desired states of control, such as armed, disarmed and on-watch, as further described herein, for either individual control points, or groups of control points, depending on the requirements of the particular mode.

Automation system 10 comprises principal control system 12 and a plurality of control systems 14. In a preferred embodiment, automation system 10 comprises security system 16, the elements of which are described herein, and control systems 14, including lighting system 18, voice access system 20, thermostat system 22, and programmer system 35, and may also include individual devices such as telecommunication device 34, which are further discussed below.

Lighting system 18 is a commercially available system sold by X-10 Powerhouse, as Model No. CP290, and is of a type known to those of ordinary skill in the art. Lighting system 18 uses powerline carrier based signal to automatically switch power on or off to control modules, which can be used in conjunction with lights and other electrical appliances and devices. Its use is not limited to lighting devices only. For instance, lighting system 18 could be used to control appliances such as a coffee maker, electric heater, or other devices which can be operated by on/off switching of AC power. Lighting system 18 is connected to security system 16, using lighting interconnection 74, and is capable of receiving a control signal from security system 16. In a preferred embodiment, lighting system 18 is capable of operation independently of security system 16, in the event that security system 16 ceases to provide control signals as described above.

Voice access system 20 is shown and described in Figures 1 and 2. Voice access system 20 incorporates speech synthesizer 90. Speech synthesizer 90 is combined with components known to those of ordinary skill in the art to produce a system which allows an operator to operate security system 16 remotely through the use of telecommunications device 34, such as a touch tone telephone 34. Voice access system 20 allows an operator to operate a security system 16 remotely, by selecting the same modes that are available to the operator through HSP 40. Touch tone telephone 34 can be a telephone located in the space to be controlled, such as one or more of touch tone telephones located in a building, or, touch tone telephone 34 may be remote from the space which is to be controlled, such as a cellular telephone or telephone located in another building. Voice access module 20 also allows an operator to receive certain information from various control systems 14 which are adapted to communicate information concerning their status. Voice access system 20 also incorporates security features which require that an operator enter certain passcodes before being able to effect changes to security system 16. In particular, passcode entry is required whenever the level of security is to be reduced. Voice access system 20 also incorporates a voice-based menu scheme wherein voice access

system 20 describes to an operator the various selections which are available, and provides the operator directions as to how to make a particular selection of choice. In a preferred embodiment, control may be exercised through voice access system 20 over various elements of an automation system 10, such as security system 16, lighting system 18, and thermostat system 22. Voice access system 20 is connected to security system 16 as described herein, via voice access interconnection 76.

Thermostat system 22 comprises a thermostat of the type described in U.S. Patent 4,606,401 to Levine, et al., and U.S. Patent 4,469,274 to Levine, et al., which are hereby incorporated by reference. Thermostat system 22 comprises a communicating thermostat, such as is described in the following copending applications: "Communicating Thermostat" (U.S. Serial No. 07/811,503) by Ratz, et al., of even filing date herewith; and "Communicating Thermostat" (U.S. Serial No. 07/811,765) by Ratz, et al., of even filing date herewith; and "Electronic Time Thermostat with a Temporary Next Period Adjustment Means" (U.S. Serial No. 07/811,501), of even filing date herewith. Thermostat system 22 is capable of receiving control signals from security system 16, such that the features which are available to an operator from thermostat system 22, such as the availability to define certain set-back and set-up times and temperatures. Thermostat system 22 is also capable of being interrupted by security system 16 to define a NOW and NEXT time and temperature, such that the control of security system 16 may allow an operator to, upon invocation of certain modes, define a current control temperature which corresponds to "NOW" and a future control time and temperature which correspond to "NEXT". Thermostat system 22 is also capable of transmitting status information to security system 16 regarding the status of the control conditions of thermostat system 22, comprising current setpoints, current time settings and other parameters having to do with the schedule related to certain programmed set-back/set-up schedules. Thermostat system 22 is connected to security system 16 via bus interconnection 78.

Referring now to Figures 1, 2, 3a and 3b, programmer system 35 may be utilized to define modes for security system 16, by programming instructions related to the control of security system 16 and various of control systems 14, into memory means 46. Programmer system comprises a computer, such as a computer which is capable of executing Disk Operating System (DOS) such as are known to those of ordinary skill in the art, and a program for defining a particular mode. The program converts certain menu options related to control conditions of the various elements of automation system 10 to define a particular mode. A plurality of modes can be defined by the program and can be transferred to memory means 46 using a single step, or series of steps.

Having described security system 16 and control systems 14, including lighting control system 18, voice access system 20, thermostat system 22 and programmer system 35, the functions of these systems together is further described hereinbelow.

Prior to utilization of security system 16, security system 16 must have preprogrammed instructions 70 defining the control instructions necessary to operate security system 16 and control systems 14, stored in memory means 46. These preprogrammed instructions 70 define certain modes as described herein. This can be accomplished by connecting programmer system 35 to security system 16 via a modem, or by connecting programmer system 36 directly to security system 16 through a serial digital interface, such as an RS232 serial interface. Once programmer system 35 has been connected to security system 16, preprogrammed instructions 70 can be stored in memory means 46. Once this has been accomplished, security system 16 is available for use by an operator.

In order to operate security system 16, an operator must make a selection of a mode. This can be accomplished in one of several ways. First, selection of a mode can be accomplished by utilizing HSP 40. Secondly, a touch-tone telephone 92 located within the building can be utilized. Also, a touch-tone telephone 92 located outside of the space to be controlled can be used.

Referring now to Figure 7, once a mode has been selected, main processor 50 will retrieve preprogrammed instruction 70 from memory means 46, corresponding to the selected mode. Then main processor 50 will execute preprogrammed instructions and provide control signals to control systems 14, for which preprogrammed instructions 70 have been designated to provide a function in the mode selected. During the selection process, preprogrammed instructions 70 may also require passcode entry from touch-key pad 80 in order to ensure that an operator has sufficient authority to implement the mode selected.

Once a mode has been selected and control signals have been provided to security system 16 and effected control systems 14, the systems perform their control functions until a different mode is selected by an operator. This method of operation centers utilization of automation system 10 on certain security-based events. It is important to note, however, that control systems 14 may also incorporate time-based programming. For example, lighting system 18 may have certain time-based program instructions, such that while lights may be turned on or off intially upon execution of a mode, subsequent programming instructions within lighting system 18 may direct subsequent changes to the on/off condition of lights affected at the outset of this mode, or other lights or appliances which are capable of being controlled by lighting system 18. Similarly, thermostat system 22 may exercise time-based program events such as set-back of the temperature or set-up of the temperature based on local program instructions after a particular mode has been initiated. Further discussion regarding the implementation of modes is set forth hereinbelow.

When programmer system 35 accesses system 16 remotely via modem 100 shown in Figure 3b, it is first necessary to ensure that the call into modem 100 is from programmer 35. In order to ensure this fact, security system 16 incorporates a methodology known as the "pizza" principle, wherein when system 16 receives a telephone call, system 16 does not allow direct access to the calling device. Rather, security system 16 has resident in memory means 46, a preprogrammed instruction corresponding to a call-back telephone number. Upon receipt of a call by modem

100, security system 16, places a call through modem 100 using the telephone number which has been preprogrammed into memory means 46. In this way, it can be ensured that access for the purpose of programming security system 16 can only come from authorized locations.

This presents a problem, however, during the initial programming of memory means 46, as described herein, because one of the items of information that must be programmed in is the preprogrammed instruction 70 related to the call-back telephone number. Therefore, initial programming would not normally be possible from a remote location. However, security system 16 also incorporates in memory means 46, an authorization code related to the call-back feature. The code has associated with it a set of preprogrammed instructions 70, which instruct security system 16 to accept telephone calls from remote devices for a predetermined time period, such as fifteen minutes. Therefore, by entering a predefined passcode at HSP 40, an operator can cause main processor 50 to retrieve preprogrammed instructions 70 from memory means 46, directing that security system 16 disable its normal security provisions as described above, and accept a telephone call through modem 100 directly, without requiring that security system 16 do a call-back to initiate communication.

Returning now to Figure 6, there shown is a sample building incorporating a home automation system of the present invention. House 1000 is made up of rooms 1001, 1002 and 1003. House 1000 also has four doors 1015a through 1015d, and three windows, 1020a through 1020c. Associated with each door and window is a sensor 1025 for monitoring the position of the door or window. Also included in the house are thermostats 1035a and through 1035c, home security panels (HSP) 1030a and 1030b, security alarm control panel 1031 and lights 1040a through 1040j. House 1000 also has a swimming pool 1100. Lastly, iron 1050 is connected to relay outlet 1055, which is controlled by control panel 1031.

Control panel 1031, as described before, controls the home security, lighting, appliance and thermostat controls, although the lighting control system and the thermostat control system can operate independently of control panel 1031. Changes

to operation of the thermostat, lighting, appliance and security system can be effected through entries into security panels 1030a and 1030b. Prestored modes of operation for all of the systems can be entered at the home security panels.

Referring now to Figure 8, there shown as a plurality of possible modes for the controlling of the lighting, security and thermostat systems in House 1000. The various modes are titled, LEAVE, WAKE, POOL PARTY, WORK, SLEEP, PLAY, RETURN and OPEN. Note that in the matrix of Figure 8, an X indicates an armed security point, a P indicates program control of a particular light or thermostat, O indicates that a particular point is off, a blank space indicates that the point is unchanged over its previous condition, Y indicates that a point is turned on, and OW indicates that a point is on watch. A point that is on watch still provides an alarm indication to the control panel. However, the control panel merely provides an indication of the point opening within the building rather than sending an alarm indication to, for example, the police.

In the LEAVE mode, all access point sensors are armed, while lights 1, 2, 3, 7 and 8 are put into program mode, as are thermostats 1, 2 and 3. Program mode indicates that a point is not only being controlled by an event, but also by time. There are a number of programs available for use with a particular point. One program may wait until a predetermined time is reached according to a clock and then initiate some action. Another program may have a point in an on condition for a predetermined time after a mode has been entered, and then turn off. Yet another program may insure that a point is off regardless of the previous status of the point. In the case of lights 1, 2, 3, 7 and 8, each light may be individually programmed to turn on or off at a particular time. The operator may enter a mode at the security panel. Thereafter the control panel will send the program to the individual systems. The individual systems then compare the clock time to the program times, and turn the lights on at the times entered by the user. This process is the same for the thermostat, lighting control and appliance control systems as well.

The iron 1050 may be turned off by controlling the relay in relay outlet 1055 thus insuring that the iron is not left on after the occupant departs.

Thermostat program causes the thermostat to go to a user selected setpoint when a particular mode is entered. Thermostat setpoint for the LEAVE mode may be different from the thermostat setpoint for the WAKE mode. The security panel may request from the operator a return time so that the thermostat setpoint can be adjusted to the anticipated return time of an occupant.

In the WAKE mode, windows 1, 2, and 3 remain armed while doors 1, 2, 3 and 4 are disarmed. Lights 1, 2, 6, 8, 9 and 10 are turned off, while lights 3, 4, 5 and 7 are turned on. Again, thermostats 1, 2 and 3 may be set to preprogrammed setpoints. Note that the status of doors 1, 2, 3 and 4 has not changed over the previous period.

The mode entitled POOL PARTY may be useful where the owner of House 1000 desires to have a party around the swimming pool. In this instance, all windows remain armed, as do doors 2 and 3. However, doors 1 and 4 are placed on watch to allow access to the pool through the house, while providing only local indication of the opening of the point. Lights 1, 3, 5, 7, 9 and 10 are forced on, and providing lighting to and at the swimming pool. Note that lights 2 and 4 remain in the same status that they were in prior to entry of the mode POOL PARTY, so that other occupants of the house are unaffected by a change in the mode. Lights 6 and 8 are forced off to indicate that no one should enter room 1003. In addition, the thermostat setpoints are unchanged, because it may remain desirable to keep the already-reached setpoint.

The mode entitled WORK arms all access points, and programs lights 1 and 3 to turn on at a preselected time. This allows the house to appear occupied even though the owner of House 1000 may not have yet arrived back at home. Lights 2, 4, 5, 6, 7, 8, 9 and 10 are forced off to save energy. Thermostats 1, 2 and 3 may enter a programmed setback mode in which temperature during the heating season is

reduced over when the building is occupied and, during the cooling season, increased over when the building is occupied.

The mode entitled SLEEP arms all access points and turns off all lights. In addition, thermostats 1, 2 and 3 have their setpoints modified to a lower temperature during the heating season, and a higher temperature during the cooling season.

The mode entitled PLAY could be used, for example, when children are to play in room 1002, but the parents wants to ensure that there is no playing near the swimming pool. Door 4 remains in an on watch status. This way, a local indication of the change in point status occurs. In addition, no changes in light status or thermostat status occur in this mode.

The mode entitled RETURN arms doors 1, 2, 3 and 4 while modifying the thermostat setpoint. This could be used, for example, where a LEAVE mode was entered prior to leaving the house and the occupant has returned thereafter. The windows remain unarmed in case the owner wants to open the windows for ventilation. Thermostat setpoints of thermostats 1, 2 and 3 can be adjusted using the programs, for occupant comfort.

Lastly, the mode entitled OPEN allows access through any access point, while leaving the remainder of the system unaffected.

Figure 9 is a flowchart of the process used in the central control panel to effect changes when a mode has been entered at one of the user operator panels. After starting at block 1205, decision block 1210 asks the question whether the mode has been changed at the operator panel. If not, the control panel returns to block 1210 and waits for a mode change.

If the mode has changed, another decision block, 1215, is reached. At decision block 1215, the process asks whether a reduction in security is occurring. A reduction in security for this process is defined as a point changing status from armed to on watch, armed to unarmed or on watch to unarmed. If the level of security is decreased, the process requires entry of a valid passcode before the process allows the changes, as noted in decision block 1216. If no valid passcode is entered, the process

returns to block 1210. If a valid passcode is entered, the process moves to block 1220. If no decrease in security occurs, the process goes directly from block 1215 to block 1220.

At decision block 1220, the control panel asks whether the lighting system requires any changes based on the mode entered. If the answer is yes, block 1225 indicates that the control panel makes the required changes for the selected mode and returns to the process at block 1230. If no lighting system changes are required, then the process continues on to block 1230 unimpeded.

At block 1230, the control panel determines whether the mode entered requires any thermostat changes. If thermostat changes are required, they are initiated at block 1235. Note that this may mean that a program is initiated which causes a temperature change to the initial mode change, coupled with a later temperature change in anticipation of reoccupancy of the house. The process then returns to decision block 1240. If no thermostat changes are required, the process moves on to decision block 1240 unimpeded.

At block 1240 the control panel asks whether security system changes are required. If the answer is yes, the control panel makes the required changes at block 1245. If the answer is no, then the process returns to block 1215, delays for a predetermined time, and starts again.

The foregoing has been a description of a novel and nonobvious system for automating the control of a space. The inventors do not intend for this description to be limiting, but instead describe their invention through the following claims.

We Claim:

1. An automation system for automating the control of a space, comprising:
a principal control system having a main processor means, a memory means connected to said main processor means, and a plurality of interconnections, said principal control system capable of receiving an input identifying a desired control mode from an operator, transmitting information related to the control mode identified by the input which has been previously stored in the memory from the memory to the main processor means, and generating a plurality of control instructions from the information.

2. The automation system of claim 1, further comprising:
a plurality of control systems, each interconnected to said principal control system via the interconnections, and each having a control processor means capable of receiving control instructions from said main processor means and executing certain control functions.

3. The automation system of claim 2, wherein said primary control system comprises a security system.

4. A method of automating the control of a space having a security system and a plurality of control systems related to the space, comprising the steps of:
selecting a control mode, said control mode comprising a preprogrammed set of instructions defining a control condition for the security system space and a control conditions for one of the plurality of control systems;
communicating the preprogrammed set of instructions to the security system for execution by the security system;

transmission of control instructions to the control system identified in said preprogrammed set of instructions corresponding to the desired control condition; and

executing said preprogrammed set of instructions within the security system corresponding to the desired control condition.

5. The method of claim 4, further comprising the step of:

communicating information regarding the status of the security system and the control system to a device which can be interrogated by an operator.

6. A system for automatically controlling a space comprising:

a principal control system having a main processor means, a memory means and a plurality of interconnections, said principal control system controlling at least one set of conditions within a space such as security conditions, lighting conditions and temperature conditions, said principal control system also adapted to issue control instructions to a plurality of devices controlling other conditions within the space;

at least one control system, said at least one control system connected to and capable of receiving the control instructions from said principal control system through the interconnections, said control system controlling at least one set of conditions within the space not controlled by said principal control system; and

at least one control mode comprising a set of preprogrammed instruction stored within the memory means, said control mode defining control parameters for the conditions controlled by said principal control system and said control system, wherein an operator may select the control mode and cause preprogrammed instructions in the memory means associated with said control mode to be communicated to the processor means and processor means takes the preprogrammed instructions and issues corresponding control instructions to said principal control system and said control system, thereby causing them to execute the conditions for the space defined by said control mode.

7. The system of claim 6, further comprising:

a man machine interface means for making the control condition options, including said at least one control mode, available to the operator; receiving the operator's selection of control condition options, such as said at least one control mode; and communicating the control condition selected to said principal control system.

8. The system of claim 7 wherein the man machine interface means comprises a home security panel having a display, a touch key pad and a home security panel processor means interconnected to said principal control system, such that control condition options are made available to the operator on the display, the touch key pad is utilized by the operator to select control condition options, and home security panel processor means communicates the selection to said principal control system.

9. The system of claim 8 wherein the interconnection connecting said home security panel and said principal control system is a data bus.

10. The system of claim 9 wherein the data bus utilizes 4 bit to 8 bit decoding/encoding, such that the processor means of said principal control system and the home security panel processor means of said home security panel can process 8 bit code words while communications between the devices is accomplished by transmission of 4 bit data words.

11. The system of claim 7 wherein the man machine interface means comprises a voice access system having a speech synthesizer means, and a touch tone telephone.

12. The system of claim 6 wherein said principal control system is a security system.

13. The system of claim 12 wherein the control system is a thermostat.

14. The system of claim 13 wherein the interconnection connecting said thermostat and said security system is a data bus.

15. The system of claim 14 wherein the data bus utilizes 4 bit to 8 bit decoding/encoding, such that the processor means of said security system and a thermostat processor means in the thermostat can process 8 bit code words while communications between the devices is accomplished by transmission of 4 bit data words over the data bus.

16. The system of claim 12 wherein said control system is a lighting control system.

17. The system of claim 6, further comprising:

a programmer system for programming the preprogrammed instructions associated with said control modes into the memory means, and detachably interconnected to said principal control system, such that the programmer system can be utilized for programming the memory means and then removed when its use is not required.

18. The system of claim 17 wherein the programmer system comprises a personal computer.

19. A system for automatically controlling a space, comprising:

a security system having a main processor means, a memory means and a plurality of interconnections, said security system controlling the security conditions comprising parameters for a plurality of security related devices, said security system also adapted to issue control instructions to a plurality of devices controlling other conditions within the space;

a plurality of control systems, said control systems connected to and capable of receiving the control instructions from said principal control system

through the interconnections, said control systems each controlling at least one set of conditions within the space not controlled by said principal control system; and

at least one control mode comprising a set of preprogrammed instruction stored within the memory means, said control mode defining control parameters for the conditions controlled by said security system and said control systems, wherein an operator may select the control mode and cause preprogrammed instructions in the memory means associated with said control mode to be communicated to the processor means and processor means takes the preprogrammed instructions and issues corresponding control instructions to said security system and said control systems, thereby causing them to execute the conditions for the space defined by said control mode.

20. The system of claim 19 wherein said plurality of control systems comprise a thermostat and a lighting control system.

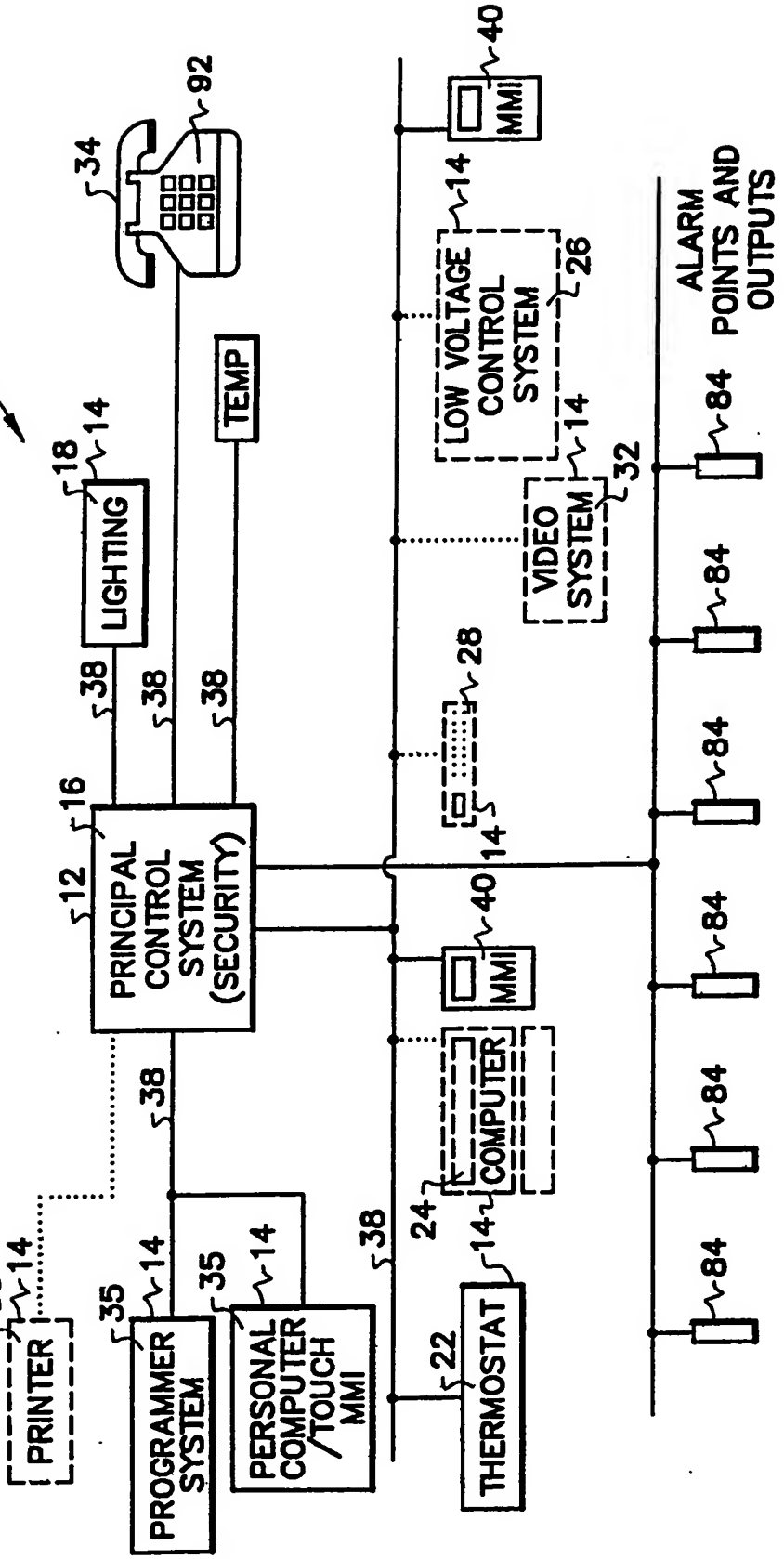

10
92
34
40
MMI
14
LOW VOLTAGE CONTROL SYSTEM
26
ALARM POINTS AND OUTPUTS
TEMP
18
14
LIGHTING
VIDEO SYSTEM
32
84
38
28
16
12
PRINCIPAL CONTROL SYSTEM (SECURITY)
MMI
COMPUTER
24
PRINTER
30
PROGRAMMER SYSTEM
35
PERSONAL COMPUTER /TOUCH MMI
THERMOSTAT
22

Fig. 1

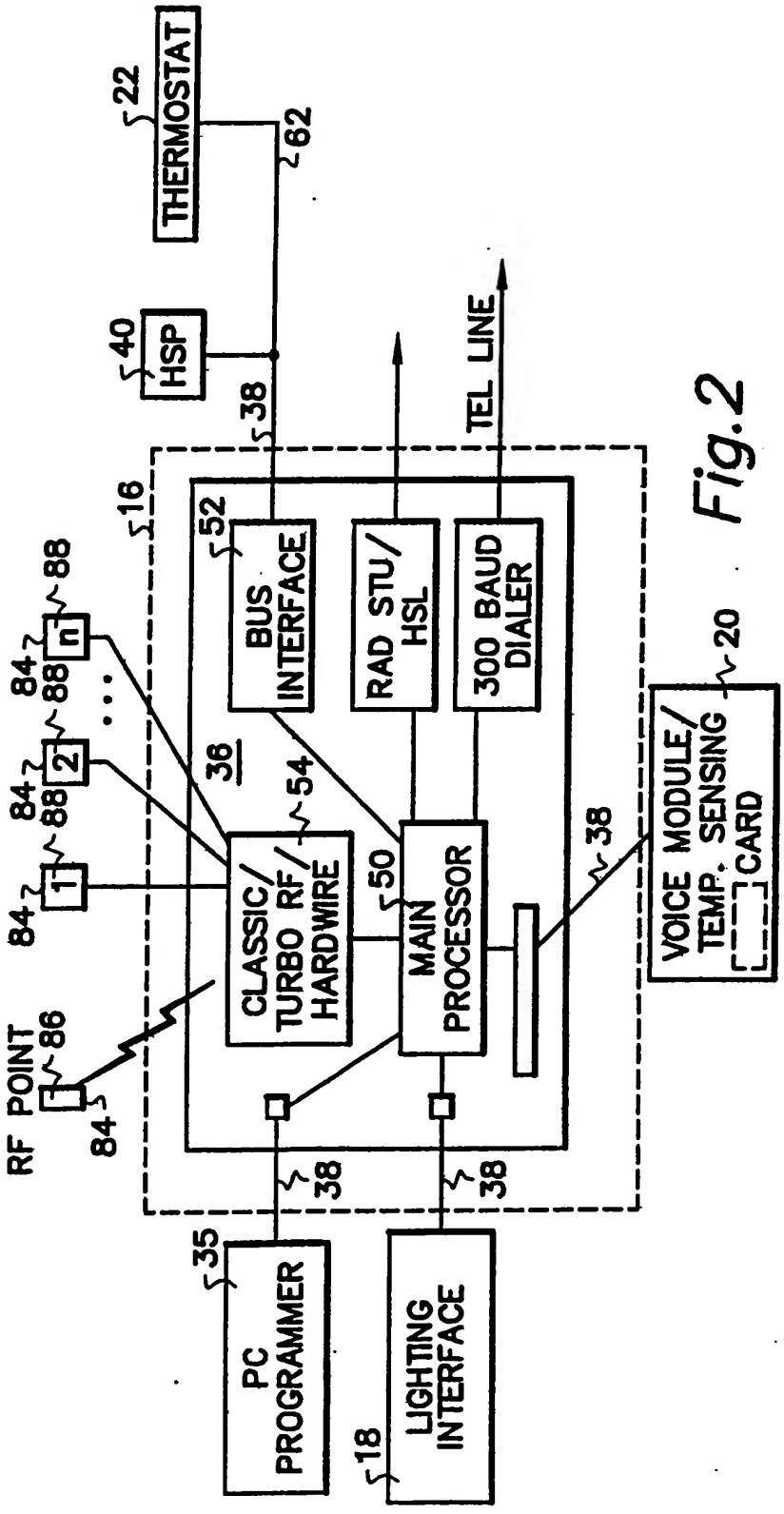
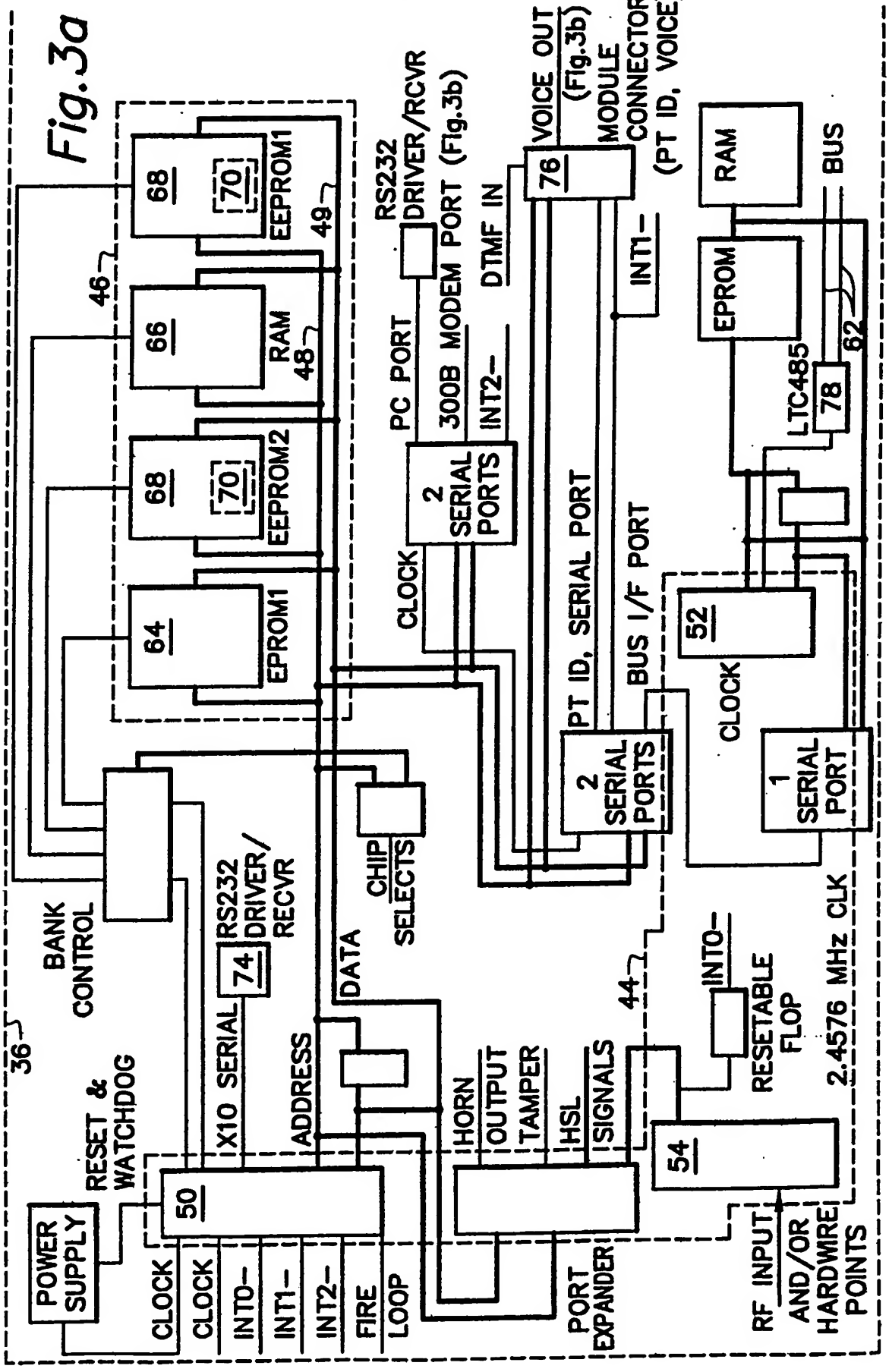

THERMOSTAT
22
62
HSP
40
38
TEL LINE
16
52
BUS INTERFACE
RAD STU/ HSL
300 BAUD DIALER
VOICE MODULE/ TEMP. SENSING CARD
20
88
n
84
88
2
84
88
1
84
36
54
CLASSIC/ TURBO RF/ HARDWIRE
50
MAIN PROCESSOR
38
RF POINT
86
84
38
38
35
PC PROGRAMMER
LIGHTING INTERFACE
18

Fig.2

Fig.3a


36
POWER SUPPLY
RESET & WATCHDOG
50
CLOCK
CLOCK
INT0-
INT1-
INT2-
FIRE
LOOP
X10 SERIAL
74
RS232 DRIVER/ RECVR
BANK CONTROL
64
EPROM1
66
RAM
48
68
70
EEPROM2
68
70
EEPROM1
46
49
ADDRESS
DATA
CHIP SELECTS
CLOCK
2 SERIAL PORTS
PC PORT
RS232 DRIVER/RCVR
300B MODEM PORT (Fig.3b)
INT2-
DTMF IN
HORN
OUTPUT
TAMPER
HSL
SIGNALS
PORT EXPANDER
44
54
INT0-
RESETABLE FLOP
2.4576 MHz CLK
RF INPUT AND/OR HARDWIRE POINTS
PT ID, SERIAL PORT
BUS I/F PORT
2 SERIAL PORTS
52
CLOCK
1 SERIAL PORT
INT1-
76
VOICE OUT (Fig.3b)
MODULE CONNECTOR (PT ID, VOICE)
RAM
EPROM
LTC485
78
62
BUS

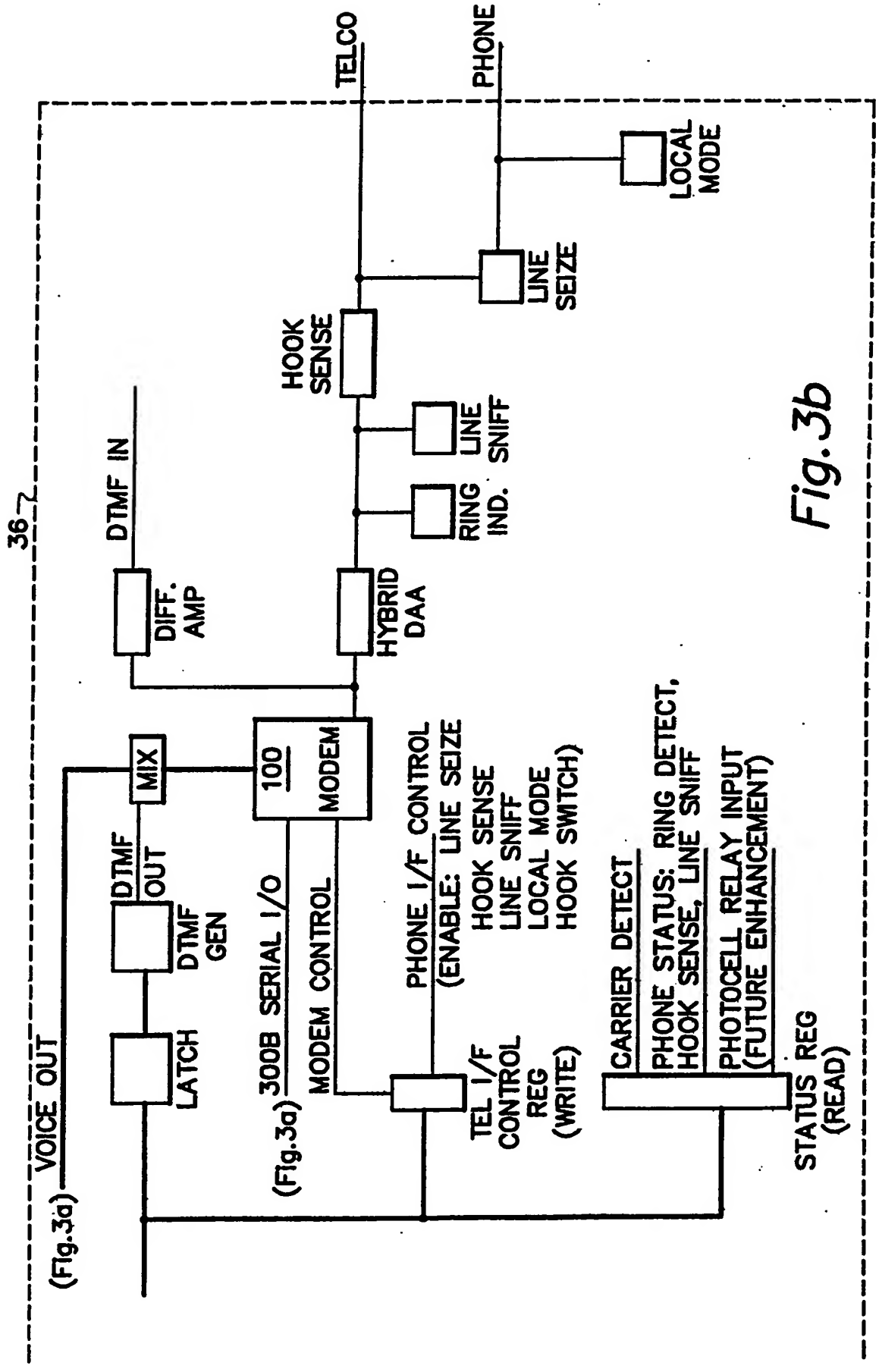

TELCO
PHONE
LOCAL MODE
LINE SEIZE
HOOK SENSE
LINE SNIFF
RING IND.
DTMF IN
DIFF. AMP
HYBRID DAA
36
MIX
100
MODEM
DTMF OUT
DTMF GEN
LATCH
VOICE OUT
(Fig.3a)
300B SERIAL I/O
(Fig.3a)
MODEM CONTROL
PHONE I/F CONTROL
(ENABLE: LINE SEIZE
HOOK SENSE
LINE SNIFF
LOCAL MODE
HOOK SWITCH)
TEL I/F CONTROL REG (WRITE)
CARRIER DETECT
PHONE STATUS: RING DETECT, HOOK SENSE, LINE SNIFF
PHOTOCELL RELAY INPUT (FUTURE ENHANCEMENT)
STATUS REG (READ)

Fig. 3b

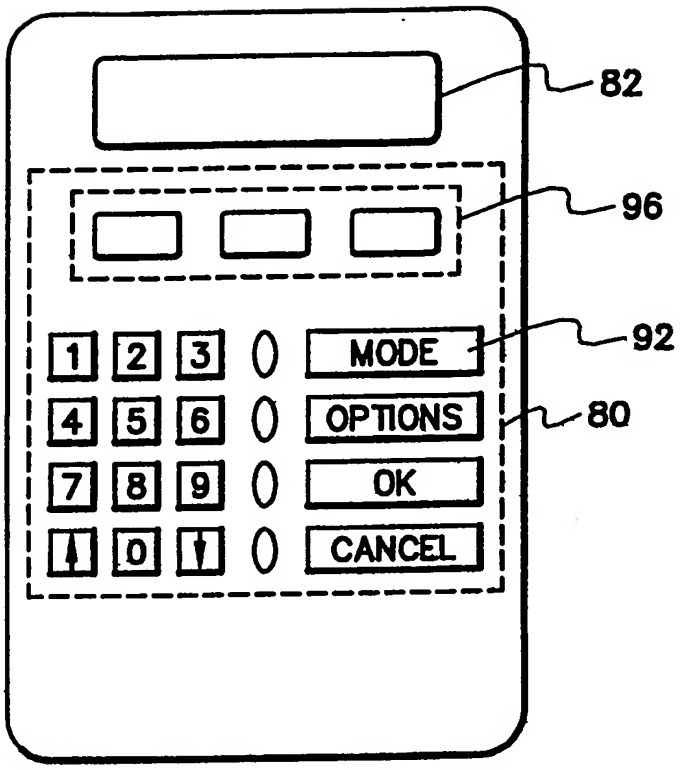


Fig. 4

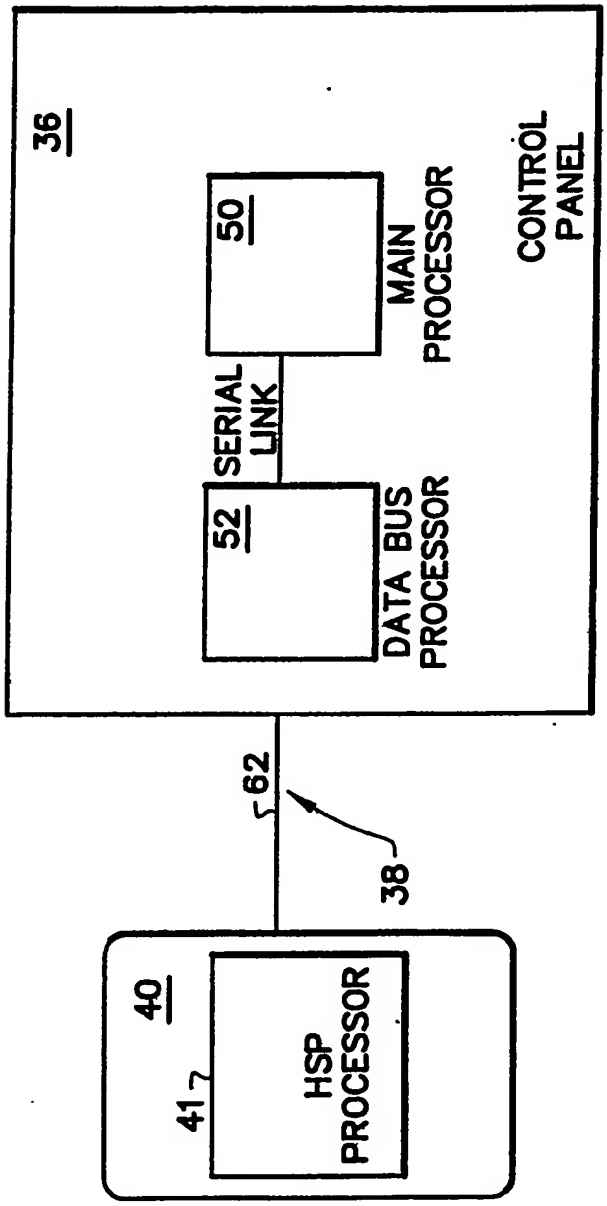

36
CONTROL PANEL
50
MAIN PROCESSOR
SERIAL LINK
52
DATA BUS PROCESSOR
62
38
40
41
HSP PROCESSOR

Fig.5

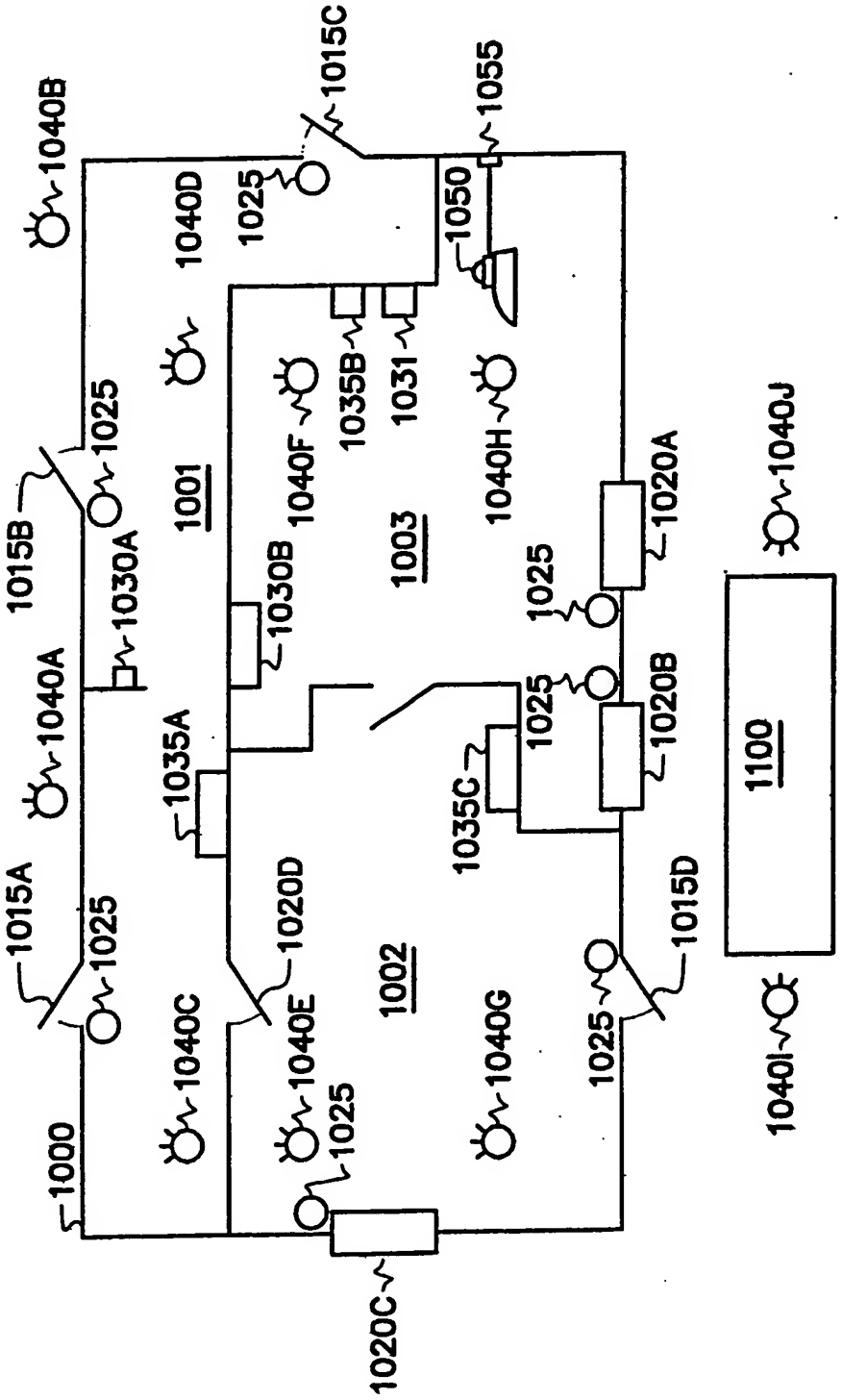

1040B
1015C
1055
1040D
1025
1050
1035B
1031
1040F
1040H
1025
1001
1003
1030B
1030A
1015B
1040A
1035A
1020A
1040J
1025
1020B
1035C
1100
1015A
1025
1020D
1002
1040C
1040E
1040G
1025
1015D
1000
1025
1040I
1020C

Fig. 6

FIGURE ID NO	NAME	MODES								
		POINT NO.	LEAVE	WAKE	POOL PARTY	WORK	SLEEP	PLAY	RETURN	OPEN
1020A	WINDOW 1	1	X	X	X	X	X	O	O	O
1020B	WINDOW 2	2	X	X	X	X	X	O	O	O
1020C	WINDOW 3	3	X	X	X	X	X	O	O	O
1015A	DOOR 1	4	X	O	OW	X	X	O	X	O
1015B	DOOR 2	5	X	O	X	X	X	O	X	O
1015C	DOOR 3	6	X	O	X	X	X	O	X	O
1015D	DOOR 4	7	X	O	ON	X	X	ON	X	O
1040A	LIGHT 1	8	P	O	Y	P	O			
1040B	LIGHT 2	9	P	O		O	O			
1040C	LIGHT 3	10	P	Y	Y	P	O			
1040D	LIGHT 4	11	O	Y		O	O			
1040E	LIGHT 5	12	O	Y	Y	O	O			
1040F	LIGHT 6	13	O	O	O	O	O			
1040G	LIGHT 7	14	P	Y	Y	O	O			
1040H	LIGHT 8	15	P	O	O	O	O			
1040J	LIGHT 9	16	O	O	Y	O	O			
1040K	LIGHT 10	17	O	O	Y	O	O			
1035A	THERMOSTAT 1	18	P	P		P	P		P	
1035B	THERMOSTAT 2	19	P	P		P	P		P	
1035C	THERMOSTAT 3	20	P	P		P	P		P	
1055	OUTLET	21	P							

Fig. 7

X= ARMED

P= PROGRAMMED

O= OFF

Y= ON

OW= ON WATCH

BLANK= NO EFFECT OVER PREVIOUS STATUS

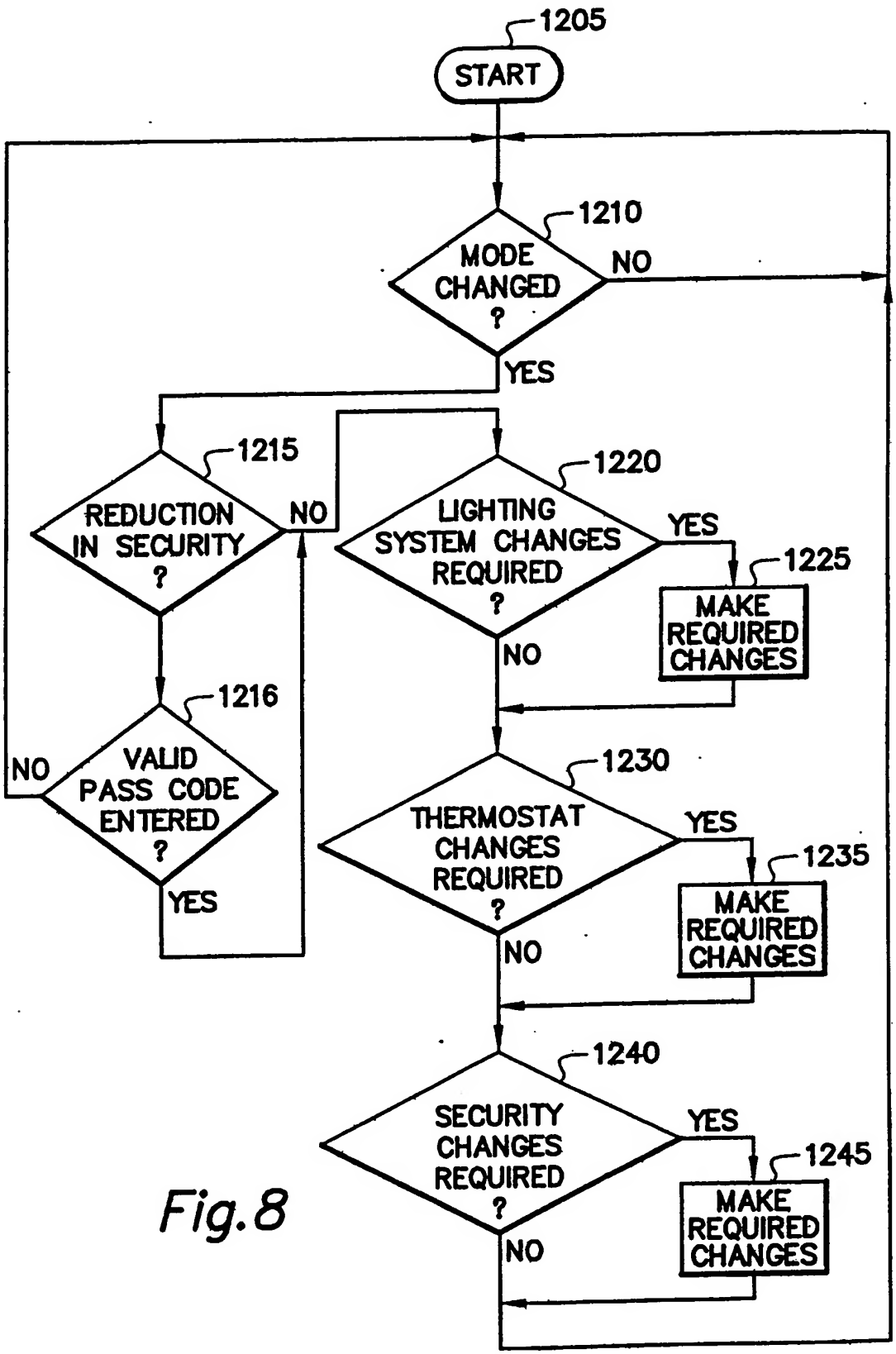

1205
START
1210
MODE CHANGED ?
NO
YES
1215
REDUCTION IN SECURITY ?
NO
1220
LIGHTING SYSTEM CHANGES REQUIRED ?
YES
1225
MAKE REQUIRED CHANGES
NO
1216
NO
VALID PASS CODE ENTERED ?
YES
1230
THERMOSTAT CHANGES REQUIRED ?
YES
1235
MAKE REQUIRED CHANGES
NO
1240
SECURITY CHANGES REQUIRED ?
YES
1245
MAKE REQUIRED CHANGES
NO

Fig.8

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 92/11262

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 G08B19/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	G08B ; H04L ; H02J

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category*	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	EP,A,0 210 889 (AZUR ELECTRONIQUE SERVICE) 4 February 1987 see page 3, line 16 - page 7, line 4	1-8, 11-13,19
A	see figures 1,2	17

X	IEEE TRANSACTIONS ON CONSUMER ELECTRONICS vol. 29, no. 1, February 1983, NEW YORK US pages 1 - 8 E. BRUGGEMAN, I. SANDERS 'A MULTIFUNCTION HOME CONTROL SYSTEM'	1-3
A	see the whole document	4-8, 11-13, 16,19,20

X	FR,A,2 606 524 (TRACI LES MAISONS FRANÇAISES) 13 May 1988	1-8
A	see page 2, line 12 - page 6, line 30; figures 1-8	12,13,16

	-/--	

* Special categories of cited documents :[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
30 MARCH 1993	06.04.93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	GOETZ P.A.

Form PCT/ISA/210 (second sheet) (January 1985)

International Application No

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category*	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	NEC RESEARCH AND DEVELOPMENT no. 97, April 1990, TOKYO JP pages 57 - 65 S. TSUMURA ET AL. 'A HIGH PERFORMANCE POWER LINE SPREAD-SPECTRUM MODEM' see page 63, paragraph 6 - page 65, paragraph 7; figures 10,11	1-9, 11-14, 17-20
A	IEEE TRANSACTIONS ON CONSUMER ELECTRONICS vol. 32, no. 3, August 1986, NEW YORK US pages 558 - 565 K. IIDA ET AL. 'HOUSEKEEPING APPLICATION WITH BUS LINE AND TELECOMMUNICATION' see the whole document	1-20

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9211262 SA 68642

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 30/03/93
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0210889	04-02-87	FR-A- 2584219	02-01-87
FR-A-2606524	13-05-88	None	